IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. . . . . Unknown
Filing Date . . . . . Filed Herewith
Inventor . . . . . Shane P. Leiphart
Assignee . . . . . Micron Technology, Inc.
Group Art Unit . . . . . Unknown
Examiner . . . . . Unknown
Attorney's Docket No. MI22-1636
Title: Method of Forming an Aluminum Comprising Line Having a Titanium Nitride Comprising Layer Thereon

PRELIMINARY AMENDMENT

To: Box Patent Application
Assistant Commissioner for Patents
Washington, D.C. 20231

From: Mark S. Matkin (Tel. 509-624-4276; Fax 509-838-3424)
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Please enter the following amendments prior to examining the above-identified application.

AMENDMENTS

In the Specification

At p. 1 before the "Technical Field" section, please insert the following:

--**RELATED PATENT DATA**

This patent resulted from a continuation application of U.S. Patent Application Serial No. 09/378,651, filed August 19, 1999, entitled "Method of Forming an Aluminum Comprising Line Having a Titanium Nitride Comprising Layer Thereon", naming Shane P. Leiphart as inventor, the disclosure of which is incorporated by reference.--

In the Claims

Cancel claims 1-34.

Add new claims 35-74 as follows:

35. (Added) A method of forming an aluminum comprising line having a titanium nitride comprising layer thereon, the method comprising:

in a processing tool, physical vapor depositing a first layer comprising at least one of elemental aluminum or an aluminum alloy over a substrate in a first chamber, at least an outermost portion of the first layer being deposited at a first deposition temperature of at least 400°C;

after the first layer physical vapor depositing and without letting the outermost portion of the first layer cool from the first deposition temperature to a temperature below 360°C, physical vapor depositing at least one of elemental titanium or a titanium alloy on the first layer in a second chamber of the processing tool while at least an outer portion of the first layer is at a temperature of at least about 360°C, and forming therefrom a second layer comprising an alloy of titanium and the aluminum from the first layer in the second chamber during said depositing, the alloy having a higher melting point than that of the first layer, and wherein essentially all the physical vapor deposited titanium alloys with the aluminum of the first layer;

physical vapor depositing a third layer comprising titanium nitride on the second layer in the second chamber of the processing tool;

removing the substrate from the processing tool after depositing the third layer; and

forming first, second and third layers into a conductive line.

36. (Added) The method of claim 35 comprising depositing the second layer to have a thickness of from about 50 Angstroms to about 150 Angstroms.

37. (Added) The method of claim 35 comprising depositing the second layer to have a thickness of from about 100 Angstroms to about 200 Angstroms.

38. (Added) The method of claim 35 wherein the first layer consists essentially of elemental aluminum, an aluminum alloy, or a mixture thereof.

39. (Added) The method of claim 35 wherein the first layer consists essentially of elemental aluminum.

40. (Added) The method of claim 35 wherein the physical vapor depositing at least one of elemental titanium or a titanium alloy comprises physical vapor depositing elemental titanium.

41. (Added) The method of claim 35 wherein temperature of at least an outer portion of the first layer is at least about 360°C during the physical vapor depositing of the third layer.

42. (Added) The method of claim 35 wherein the third layer physical vapor depositing occurs in the second chamber of the processing tool.

43. (Added) The method of claim 35 wherein the physical vapor depositing of at least one of elemental titanium or a titanium alloy on the first layer in the second chamber of the processing tool comprises physical vapor depositing a titanium alloy layer, and forming therefrom a second layer comprising an alloy of titanium and the aluminum from the first layer in the second chamber during said depositing.

44. (Added) The method of claim 35 wherein the first deposition temperature is at least about 450°C.

45. (Added) The method of claim 35 wherein the first deposition temperature is greater than 450°C.

46. (Added) The method of claim 35 wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

47. (Added) The method of claim 35 wherein the first deposition temperature is at least about 450°C, and wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

48. (Added) The method of claim 35 wherein the first deposition temperature is greater than 450°C, wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

49. (Added) A method of forming an aluminum comprising line having a titanium nitride comprising layer thereon, the method comprising:

forming a first layer comprising at least one of elemental aluminum or an aluminum alloy over a substrate, at least an outermost portion of the first layer being formed at a first forming temperature of at least 400°C;

after forming the first layer and without letting the outermost portion of the first layer cool from the first forming temperature to a temperature below 360°C, depositing titanium onto the first layer and forming therefrom during the depositing an alloy of titanium and the aluminum from the first layer, the alloy having a higher melting point than that of the first layer;

forming a third layer comprising titanium nitride over the second layer; and

forming the first, second and third layers into a conductive line.

50. (Added) The method of claim 49 wherein the first forming temperature is at least about 450°C.

51. (Added) The method of claim 49 wherein the first forming temperature is greater than 450°C.

52. (Added) The method of claim 49 wherein after forming the first layer and before depositing titanium, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

53. (Added) The method of claim 49 wherein the first forming temperature is at least about 450°C, and wherein after forming the first layer and before depositing titanium, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

54. (Added) The method of claim 49 wherein the first forming temperature is greater than 450°C, and wherein after forming the first layer and before depositing titanium, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

55. (Added) The method of claim 49 comprising forming the second layer to have a thickness of from about 50 Angstroms to about 150 Angstroms.

56. (Added) The method of claim 49 comprising forming the second layer to have a thickness of from about 100 Angstroms to about 200 Angstroms.

57. (Added) The method of claim 49 wherein the first layer consists essentially of elemental aluminum.

58. (Added) A method of forming an aluminum comprising line having a titanium nitride comprising layer thereon, the method comprising:

physical vapor depositing a first layer comprising at least one of elemental aluminum or an aluminum alloy over a substrate, at least an outermost portion of the first layer being deposited at a first deposition temperature of at least 400°C;

after the first layer physical vapor depositing and without letting the outermost portion of the first layer cool from the first deposition temperature to a temperature below 360°C, physical vapor depositing at least one of elemental titanium or a titanium alloy on the first layer and forming therefrom during the elemental titanium or titanium alloy depositing a second layer comprising an alloy of titanium and the aluminum from the first layer, the alloy having a higher melting point than that of the first layer;

physical vapor depositing a third layer comprising titanium nitride over the second layer; and

forming the first, second and third layers into a conductive line.

59. (Added) The method of claim 58 wherein the titanium nitride of the third layer is deposited in contact with the second layer.

60. (Added) The method of claim 58 wherein essentially all the physical vapor deposited titanium alloys with the aluminum of the first layer.

61. (Added) The method of claim 58 comprising physical vapor depositing each of the first layer, titanium, and third layer in different deposition chambers of the same processing tool.

62. (Added) The method of claim 58 comprising physical vapor depositing the titanium and third layer in the same deposition chamber.

63. (Added) The method of claim 58 comprising physical vapor depositing the first layer in two different chambers of the same processing tool, and physical vapor depositing the titanium and third layer in a common chamber of the same processing tool.

64. (Added) The method of claim 58 comprising physical vapor depositing the titanium and the third layer in the same deposition chamber without moving the substrate therefrom intermediate the titanium and third layer depositions.

65. (Added) The method of claim 58 wherein the first deposition temperature is at least about 450°C.

66. (Added) The method of claim 58 wherein the first deposition temperature is greater than 450°C.

67. (Added) The method of claim 58 comprising depositing the second layer to have a thickness of from about 50 Angstroms to about 150 Angstroms.

68. (Added) The method of claim 58 comprising depositing the second layer to have a thickness of from about 100 Angstroms to about 200 Angstroms.

69. (Added) The method of claim 58 wherein the first layer consists essentially of elemental aluminum, an aluminum alloy, or a mixture thereof.

70. (Added) The method of claim 58 wherein the first layer consists essentially of elemental aluminum.

71. (Added) The method of claim 58 wherein the physical vapor depositing at least one of elemental titanium or a titanium alloy comprises physical vapor depositing elemental titanium.

72. (Added) The method of claim 58 wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

73. (Added) The method of claim 58 wherein the first deposition temperature is at least about 450°C, and wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

74. (Added) The method of claim 58 wherein the first deposition temperature is greater than 450°C, wherein after the first layer physical vapor depositing and before beginning the physical vapor depositing of the at least one of elemental titanium or titanium alloy, letting the outermost portion of the first layer cool from the first deposition temperature by 25°C or less.

REMARKS

Claims 1-34 are cancelled. Claims 35-74 are added and are the only claims in the application.

Independent claim 35 includes all of the limitations, plus others, of the independent claim that was allowed in the parent application. The added limitations are supported by the specification as filed. Accordingly, allowance of claims 35-48 is warranted and requested.

Independent claims 49 and 58 recite that the outermost portion of the first layer is formed or deposited at a first temperature of at least 400°C. After depositing or otherwise forming the first layer, and without letting the outermost portion of the first layer cool from the first forming temperature to a temperature below 360°C, titanium in either elemental or alloy form is deposited onto the first layer and formed therefrom during such depositing is an alloy of titanium and the aluminum from the first layer. Support for the same is inherent from Applicant's application as filed.

The respective subject matter of independent claims 49 and 58 is not shown nor suggested by the previously applied art, for example Besser et al., Colgan et al. and Yoshikawa. For instance, the portion of Besser et al. relied upon by the Examiner in the parent application discloses at the bottom of column 3 a preheat step occurring to a temperature of at least 350°C after formation of the indicated aluminum or aluminum alloy layer. Accordingly, this reference inherently teaches substantial cooling of the outermost portion of the

aluminum or aluminum alloy layer after formation, as otherwise a heating step to approximately 350°C would not be necessary, and in any event does not suggest Applicant's independent claims 49 and 58 as presented.

Regarding Colgan et al., such clearly teaches an anneal subsequent to deposition to form $TiAl_3$, and accordingly, does not suggest doing so in the manner Applicant claims.

Similarly, the Yoshikawa reference depicts patterning of its subject aluminum layer 3 after formation and prior to deposition of a titanium film 4. Accordingly, inherent cooling of the Yoshikawa substrates occurs outside of the limits of Applicant's independent claims 49 and 58.

The claims of this application are believed to be in condition for allowance, and indicated action to that end is requested.

Respectfully submitted,

Dated: 2-16-01

By: _____

Mark S. Matkin
Reg. No. 32,268

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Patent Application Serial No. . . . . Unknown
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Assignee . . . . . Micron Technology, Inc.
Group Art Unit . . . . . Unknown
Examiner . . . . . Unknown
Attorney's Docket No. MI22-1636
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Assistant Commissioner for Patents
Washington, DC 20231
ATTENTION: Official Draftsman

SUBSTITUTE DRAWING REQUEST

Please enter the enclosed substitute drawings in the above-referenced application in place of drawings originally filed. These substitute formal sheets are being submitted to add/change the proper numbering of contact opening 38 in each of Figs. 2-7 in accordance with the parent application, Patent Application Serial No. 09/368,351, filed on August 19, 1999. Red-lined copies of the sheets showing the above-described corrections are submitted along with the formal drawing sheets.

Acknowledgment of receipt of the formal drawings and their acceptance into the file is requested.

Respectfully submitted,

Dated: 2-16-01

Attorney: _____
Mark S. Matkin
Reg. No. 32,268

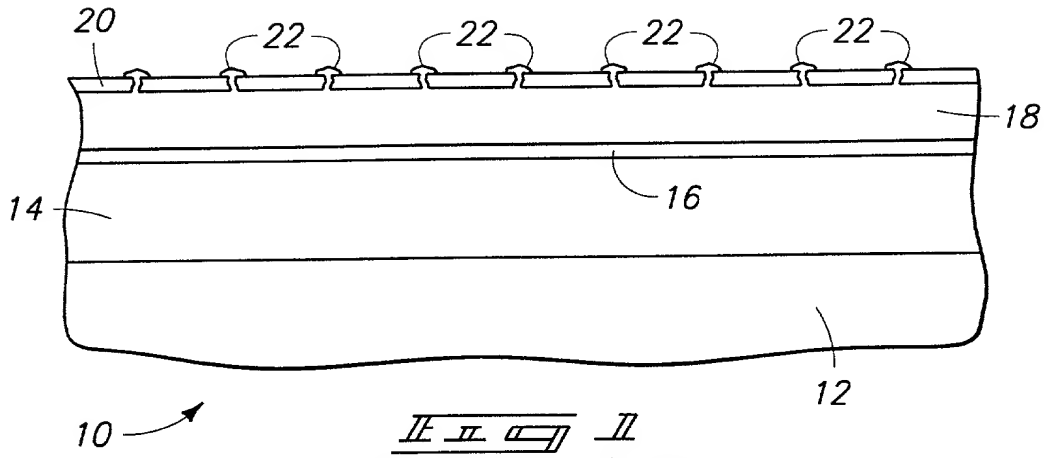

Fig 1
PRIOR ART

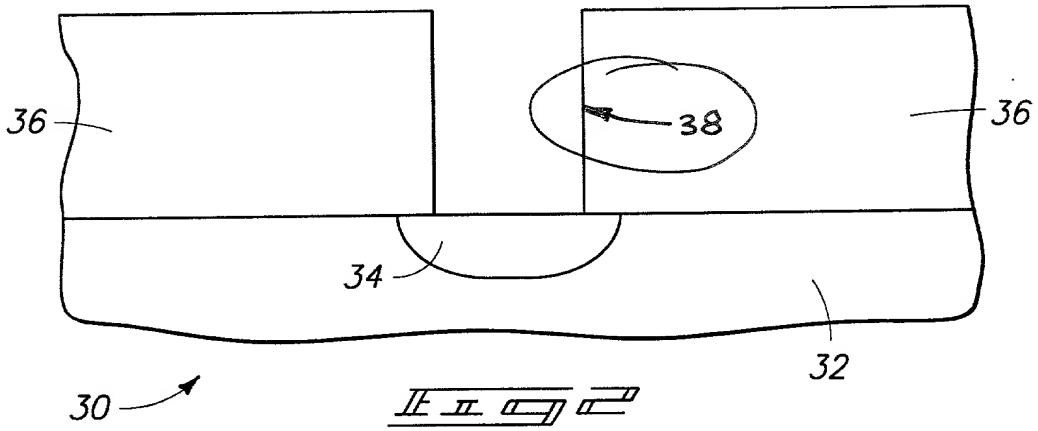

Fig 2

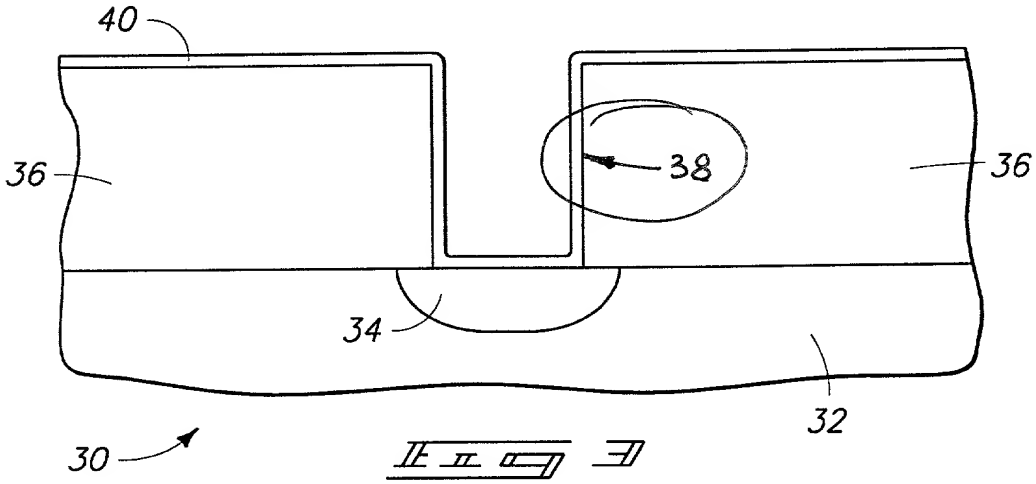

Fig 3

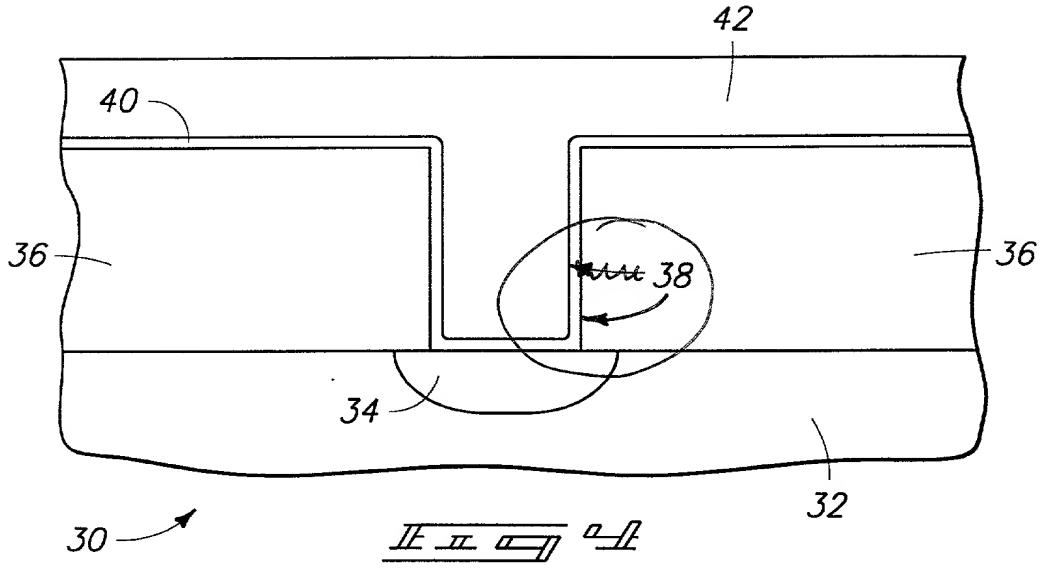

Fig 4

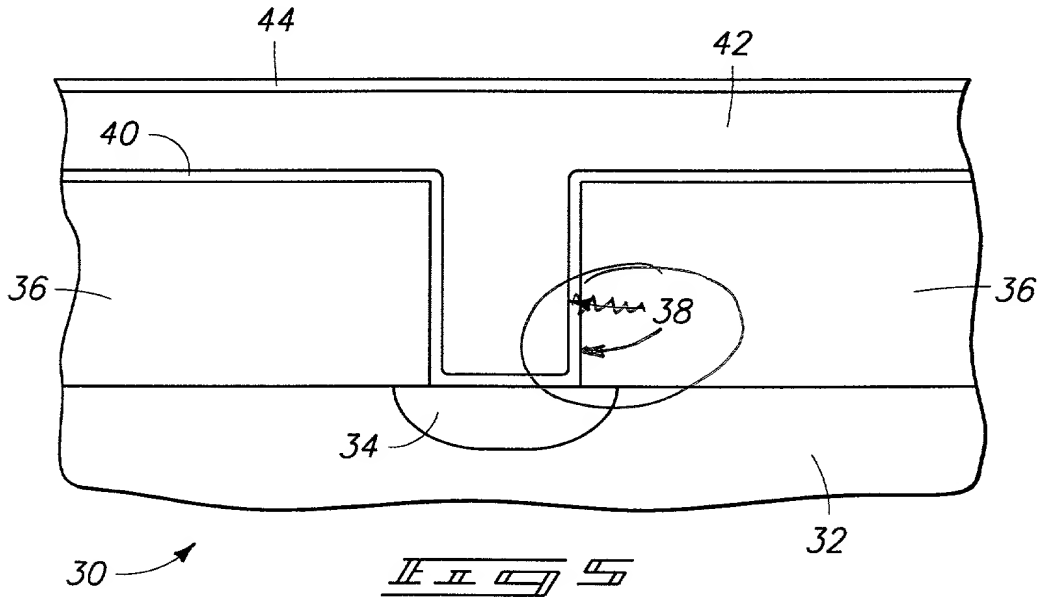

Fig 5

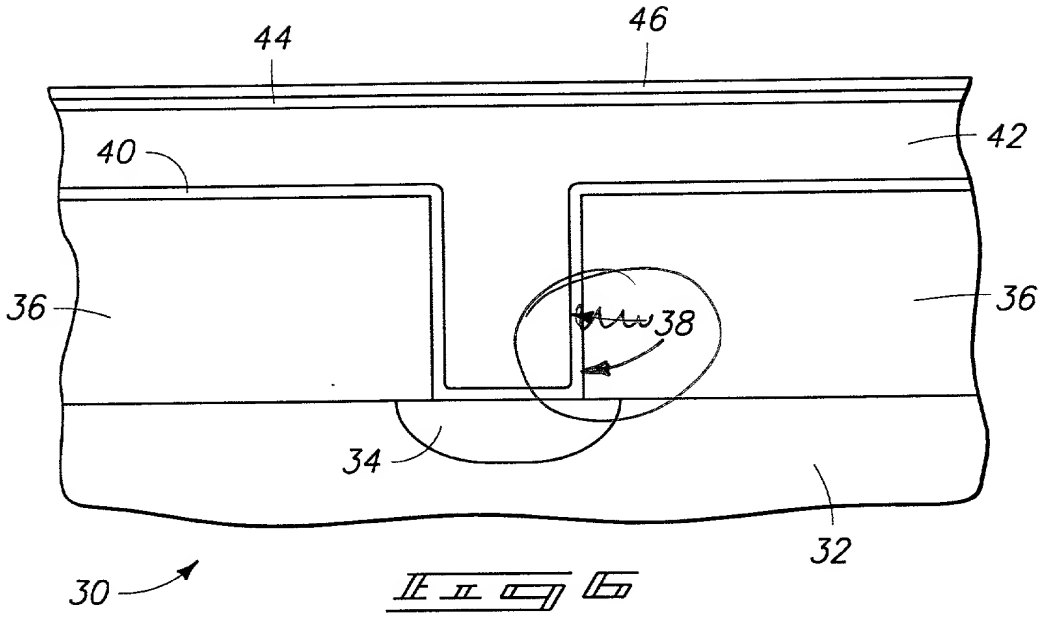

Fig 6

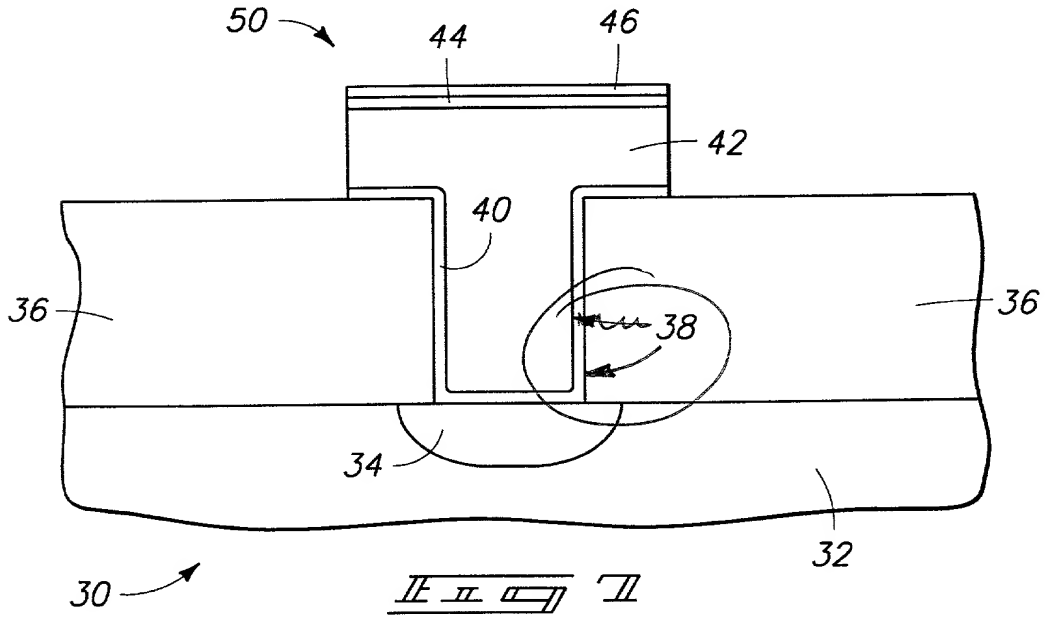

Fig 7